Notice of Allowability	Application No.	Applicant(s)	
	09/896,137	KENNON, STEPHEN R.	
	Examiner	Art Unit	
	Kandasamy Thangavelu	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *5 January 2005*.

2. ☒ The allowed claim(s) is/are *3-11 and 15-28*.

3. ☒ The drawings filed on *29 June 2001* are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 21 march 2005
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

Introduction

1. This communication is in response to the Applicant's communication dated January 5, 2005. Claims 3-11 and 15-23 were amended. Claims 24-28 were added. Claims 3-11 and 15-28 of the application are pending.

Drawings

2. The drawings submitted on June 29, 2001 are accepted.

Information Disclosure Statement

3. Acknowledgment is made of the information disclosure statements filed on March 21, 2005 together with copies of the foreign patents and papers. The patents and papers have been considered.

Reasons for Allowance

4. Claims 3-11 and 15-28 of the application are allowed over prior art of record.

5. The following is an Examiner's statement of reasons for the indication of allowable subject matter:

The closest prior art of record shows:

(1) an improved method of predicting the behavior of hydrocarbon bearing formation in an underground reservoir; the method uses a model of the reservoir involving the mass transfer and fluid flow processes in a reservoir simulation for predicting the performance behavior of the reservoir; the goal is to maximize the recovery of the hydrocarbons; the method for solving the equations discretizes the process and transforms the continuous partial differential equations into finite dimensional system of algebraic equations; the reservoir space is discretized into contiguous cells conforming to a predetermined grid pattern; the equations are constructed using finite element or finite difference method; the algebraic equations are solved for four variables – oil pressure, water pressure, oil saturation and water saturation; flow rates are computed using phase pressures and saturations at the end of each timestep; the pressure distribution is used to calculate the sum of velocities of all phases at each boundary between the cells; the method assumes that the flow of all phases is in the same direction (**Watts, III,** U.S. Patent 6,052,520);

(2) a method for automatically generating a numerical simulation program for a system represented by a set of simultaneous partial differential equations having a plurality of variables and a group of boundary conditions; the fluid flow is represented by the Stokes equation involving fluid velocities in various directions and fluid viscosity; the program uses the finite element method; the partial differential equations are transformed into a simultaneous system of linear equations related to the values of the variables at the nodes; the method diagonalizes the coefficient matrix based on the input specification; the coefficient matrix has nonzero elements

along the diagonal and zero elements off diagonal; the optimal weight function for each equation of the system is automatically selected; optimal boundary conditions are selected from the group of boundary conditions so as to control the processing of the variables (**Sagawa et al.,** U.S. Patent 5,699,271); and

(3) the integral and differential equations that describe various physical fields can be solved by numerical modeling techniques using finite element methods; the finite element method assumes that within each element, the field can be described approximately by a linear combination of simple equations such as polynomials; the physical domain of the problem is partitioned into elements of simple geometry called a mesh; the element matrix equation is a set of numerically computable mathematical formulas that are derived theoretically; the expressions for the coefficients in the matrix equation are manipulated using algebra and calculus to obtain a form that can be evaluated by a computer; the system matrix equation is then modified to take into account the boundary conditions; the matrix elements assume non-zero values only along the matrix diagonal (**Burnett et al.,** U.S. Patent 5,966,524).

5.1 Applicant's first set of claims consists of Claims 3-11.

Independent Claim 3 is directed to a method for solving a finite element model corresponding to a system in which there is a multi-phase fluid flow. The claim identifies the uniquely distinct features of:

"adjusting the coefficients to obtain the finite element matrix in which on-diagonal matrix entries are non-negative and off-diagonal matrix entries are non-positive, wherein adjusting the coefficients comprises weighting nodes of each mesh element according to a direction of fluid

flow across the mesh element, wherein weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element comprises determining the direction of fluid flow across the mesh element and weighting each node more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element".

Because the closest prior art fails to teach or fairly suggest adjusting the coefficients to obtain the finite element matrix in which on-diagonal matrix entries are non-negative and off-diagonal matrix entries are non-positive, wherein adjusting the coefficients comprises weighting nodes of each mesh element according to a direction of fluid flow across the mesh element, wherein weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element comprises determining the direction of fluid flow across the mesh element and weighting each node more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element, as claimed by the Applicant, Claims 3-11 are deemed novel and allowable.

5.2 Applicant's second set of claims consists of Claims 15-23.

Independent Claim 15 is directed to a computer-readable medium which contains a plurality of instructions, wherein the instructions are configured to cause a computer to perform the method for solving a finite element model corresponding to a system in which there is a multi-phase fluid flow. The claim identifies the uniquely distinct features of:

"adjusting the coefficients to obtain the finite element matrix in which on-diagonal matrix entries are non-negative and off-diagonal matrix entries are non-positive, wherein adjusting the coefficients comprises weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element, wherein weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element comprises determining the direction of fluid flow across the mesh element and weighting each node more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element".

Because the closest prior art fails to teach or fairly suggest adjusting the coefficients to obtain the finite element matrix in which on-diagonal matrix entries are non-negative and off-diagonal matrix entries are non-positive, wherein adjusting the coefficients comprises weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element, wherein weighting the nodes of each mesh element according to a direction of fluid flow across the mesh element comprises determining the direction of fluid flow across the mesh element and weighting each node more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element, as claimed by the Applicant, Claims 15-23 are deemed novel and allowable.

5.3 Applicant's third set of claims consists of Claims 24-28.

Independent Claim 24 is directed to a method of predicting fluid flow in a fluid reservoir. The claim identifies the uniquely distinct features of:

"selectively weighting the matrix elements based on fluid flow direction in the regional portion of the fluid reservoir represented by the mesh element associated with the matrix element by weighting each node of the mesh element more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element".

Because the closest prior art fails to teach or fairly suggest selectively weighting the matrix elements based on fluid flow direction in the regional portion of the fluid reservoir represented by the mesh element associated with the matrix element by weighting each node of the mesh element more heavily if the node is upstream from the other nodes of the mesh element and less heavily if the node is downstream from the other nodes of the mesh element, as claimed by the Applicant, Claims 24-28 are deemed novel and allowable.

6. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 571-272-3717. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on 571-272-3716. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to TC 2100 Group receptionist: 571-272-2100.

K. Thangavelu
Art Unit 2123
April 9, 2005